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## The Nesting of the Two-lined Salamander, *Eurycea bislineata*, on the Virginia Coastal Plain

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Ninety years ago Verrill (1863) reported finding a group of 40 salamander eggs attached to the underside of a stone in a stream in Maine. Although he believed these to be the eggs of the dusky salamander, "*Desmognathus fusca*," the habitat description and date of the observation enabled H. H. Wilder (1899) correctly to identify the nest as that of *Eurycea bislineata*. Since that time nests of all of the subspecies of this salamander have been found in similar habitats—with the eggs individually suspended from the under surface of stones in shallow, moving water. Records of the subspecies and the states in which their nests have been reported in these habitats are as follows:

Subspecies	States where nests found
<i>bislineata</i>	Maine (Verrill, 1863) Massachusetts (H. H. Wilder, 1899; I. W. Wilder, 1924) New York (Weber, 1928; Bishop, 1941)
<i>cirrigera</i>	North Carolina (Brimley, 1939) Florida (Carr, 1940)
<i>rivicola</i>	Indiana, Illinois, Michigan (Chicago area) (Pope, 1944)
<i>wilderae</i>	North Carolina (Dunn, 1920; Wood, 1949)

On parts of the coastal plain *Eurycea bislineata* inhabits areas in which the streams contain no stones. In these areas the egg groups must be attached to other submerged objects. Noble and Richards (1932) first reported this, in describing their receipt of a shipment of *cirrigera* eggs from Winton, Hertford County, North Carolina, in which the eggs were found attached to "waterweed, dead leaves, twigs, and moss." They were advised by their collector that the eggs had been collected on these objects, and that at least

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some of their eggs had not been laid on these objects while the specimens were in transit. Richmond (1945) first described the ecology of *bislineata* egg groups from a stream lacking rocks, on the basis of two nests from the vicinity of Lanexa, New Kent County, Virginia. One of these was located in a dead leaf dam and the other in rootlets.

All but four of the nests reported in the literature contained no more than 50 eggs; nests containing egg groups in excess of this number were regarded by Bishop (1941) as probably the product of more than one female. On February 20, 1949 the author found four egg groups\* near Williamsburg, James City County, Virginia, containing 79, 80, 180, and 257 eggs respectively. These nests were in a shallow, stagnant drainage ditch in a ravine dominantly forested by beech and white oak trees. The area of the ditch in which the nests were found was choked with water-logged dead leaves, which served to protect the nesting site from the ravages of the predacious mosquitofish, *Gambusia affinis finis holbrookii*, by providing concealment for the salamanders and obstruction to the fish. Only two of these nests were found attended by a female; in both cases the female was found beneath the eggs. The nest containing 257 eggs was remarkable in that a number of eggs had been deposited on top of the leaves, and were lying in the open under one-half inch of water; the majority of eggs were attached to dead leaves in compact clusters (Fig. 1, A). The numbers of eggs on separate leaves or leaf fragments in this

nest are as follows: 72, 63, 21, 19, 18, 13, 9, 7, 7, 6, 4, 2, 2,--6 singly, 8 unattached, and 1 each on pine needle and beech leaf stem. The distribution of the eggs in the other three nests was similar to this.

Several eggs were found attached to fine rootlets (Fig. 1, D), with their envelopes attached to the support from coinciding points. This appears to result from accidental deposition of one egg on the site of another, and is probably not evidence of "a tendency toward the form of egg-capsule found in *Desmognathus fuscus*" (Noble and Richards, 1932).

Thirteen egg groups were found attached to the lower surfaces of logs and planks; eight of these were in springs, and the remaining five were in sand-bottom streams below springs. When these nests were attached to smooth lumber surfaces, there were compact groups of eggs; when attached to rough bark, the egg groups were somewhat scattered (Fig. 1, C). The egg groups on logs and lumber contained the following numbers of eggs: 36, 38, 39, 41, 42, 44, 49, 55, 55, 55, 59, 60, and 63.

\**Eurycea b. bislineata* X *cirrigera*.

In springs where masses of grass rootlets were exposed along the banks, egg groups were found attached to these (Fig. 1, E); this type of attachment is also typical of the nests found attached to the rootlets of watercress. At

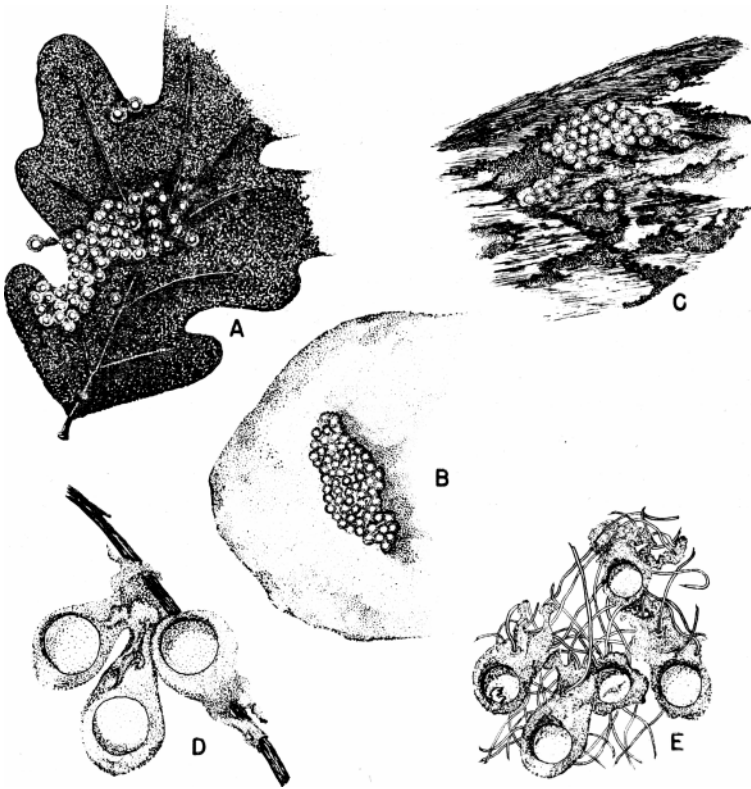


Figure 1. Groups of eggs of *Eurycea bislineata* b. *X. cirrigera* from the Virginia coastal plain. A, a compact nest attached to the under surface of a white oak leaf; B, a compact egg group attached to the under surface of a stone; C, a scattered egg group attached to the rough, lichen-covered bark of a log; D, three eggs attached to a twig, with the attachment surfaces of two envelopes overlapping to produce a "double egg stalk"; and E, the scattered grouping of eggs found attached to grass and watercress rootlets.

Yorktown, below the spring seepages feeding Upper York Creek, most of the nests were found in watercress patches on the shallow coquina seepages. If the water-depth in the nesting site was as much as one inch deep, the eggs were usually attached in grape-like clusters; if the water was less than one-

half inch deep, the eggs were found thinly scattered over a larger area, and the attending females were found in shallow depressions beneath the eggs. Evidence that these depressions were actually excavations formed by the movements of the females was obtained. When the females were removed from their pits the loose, light coquina fragments rapidly filled them up. Females returned to their nests were observed to twist about in the coquina, reforming their pits. Bishop (1941) reports no evidence of excavations by *bislineata* attending egg groups in New York. Egg groups attached to water-cress and grass rootlets contained the following numbers of eggs: 18, 33, 37, 40, 41, 46, 63, and 96.

Two other egg groups were found in masses of dead leaves, twigs, and stems; these contained 94 and 134 eggs respectively. Only one nest was found attached to the under surface of a stone,——the only stone found in a stream in this survey. At Yorktown 72 eggs were found on the underside of a large stone below a spring. The presence of this stone presents a problem. It was undoubtedly placed beneath the spring by man, and possibly arrived in the Yorktown area in the days when Yorktown was an important colonial port of entry, arriving as a ballast stone on a sailing ship. This group of eggs on the underside of a stone was a compact group (Fig. 1, B) such as has been reported in many other parts of the range of this species.

The usual nesting season for *Eurycea bislineata* in the Williamsburg area lasts for about ten weeks, extending from the last week of January through mid-April; recently deposited egg groups have been found from January 23 to April 16. Bishop (1941) reports that in the New York habitats recently deposited eggs are found from April 11 to June 25, an egg-laying period of equal duration. Egg-laying is almost completed in southeastern Virginia by the time it commences in New York State.

Bishop (1941) reports no valid record of fall egg-laying. On November 20, 1949 the author found a single unattached *bislineata* egg in a spring near Williamsburg. Removal of all leaves in the spring, and excavation into the bank from which the spring flowed, failed to reveal additional specimens. The egg contained a well-formed embryo that emerged in captivity on November 27th, with a total length of approximately 12 mm. It remained in captivity without feeding until December 28, 1949 at which time it was killed and preserved; its total length at this time was 20.0 mm. One month later the author returned to the spring and collected 16 larvae with total lengths averaging 21.0 mm. These specimens can only be explained on the basis of having come from the same egg group as the earlier specimen, or from other eggs deposited at approximately the same time.

I. W. Wilder (1924) reports that the numbers of eggs in nests are consistent with the numbers of large ova in gravid females from the same region. Several reasons why field counts of eggs of *bislineata* are unreliable as evidence of the size of ova complements are as follows:

(1) Counting errors. Field conditions often make accurate counts of the eggs in uncollected egg groups impossible.

(2) Water turbulence. The erosive effects of water flow can liberate eggs from their attachment surfaces prior to the time of larval emergence. This is particularly true in areas where eggs are attached to decaying, water-logged leaves and fine rootlets. Near the time of hatching many eggs have been noted lying free on the bottoms of ditches and springs in the Williamsburg area.

(3) Losses during deposition. Noble and Richards (1932) described the manner in which eggs are dislodged and lost during egg-laying by the actions of the female.

(4) Egg destruction. Baldauf (1947) cites evidence that the dusky salamander, *Desmognathus f. fuscus*, will under some circumstances eat the eggs it has been attending. Natural predators such as the mosquitofish, *Gambusia affinis holbrooki*, have been observed to attack and destroy eggs in a laboratory tank. This is particularly true when the embryo is developed enough to move about and attract the attention of the fish.

(5) Multiple depositions. Weber (1928), Bishop (1941), and the author have reported nests containing far greater numbers of eggs than could have been deposited by one female.

(6) Partial depositions. I. W. Wilder (1924), Bishop (1941), and the author list nests containing so few eggs that it is possible that the egg-laying process has been interrupted by predators or competitors, or other factors.

(7) Date of observations. The author has noted that nests counted near the time of larval emergence frequently contained fewer eggs than those counted at the time of egg deposition; possibly emergence of some of the larvae accounts for this.

#### Summary

1. In areas where streams do not contain stones, the eggs of *Eurycea bislineata* are deposited on the underside of a variety of surfaces, or attached to roots, stems, and other objects. Rarely they are found deposited on the

2. Egg-laying in southeastern Virginia lasts approximately ten weeks, starting in late January and terminating in mid-April.
3. Fall egg-laying, and excavation of pits under nests, have been observed; neither is typical of the majority of *bislineata* in the region studied.
4. Field counts of egg groups do not constitute valid evidence of the large ova complements of gravid females from the same region.

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